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Author(s): Rasmus G. Winther
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kinds do match: momentum. What Dowe seems reluctant to use is the notion of appropriate *quantities.* If a mosquito and a brick hit a window at the same time, both exchange energy and momentum with the glass, but the brick causes the window to break, while the mosquito does not. The reason is that the mosquito's energy and momentum were not sufficient to account for breaking the glass: the quantities are wrong.

Hopefully, such considerations can suffice for proper connections. The other option is to appeal to identities of CQ's: whether the glass now has the same momentum the ball had (not just the same quantity thereof). I suspect it would be harder to make such a theory empirical.

CHARLES TWARDY, MONASH UNIVERSITY

Deborah Gordon, ***Ants at Work: How an Insect Society is Organized.*** New York: The Free Press (1999), x + 182 pp., $25.00 (cloth); New York: W. W. Norton & Co. (2000) $13.95 (paper).

In her new book Deborah Gordon, a professor of biology at Stanford University, presents her research program on the behavior of the red seed-harvester ant *Pogonomyrmex barbatus.* In a manner intended for a general audience, Gordon recounts the trials and tribulations she and her co-workers endured to map, census, observe, perturb, and excavate colonies in the scorching desert of southeastern Arizona. Once back in her laboratory she observed behavior within and among excavated colonies both with and without extensive perturbation. She also modeled behavior using computer simulations. There is voluminous material here for a philosopher, or sociologist, of science interested in analyzing the local and contingent practices and concepts of a scientist at work.

Perhaps because the book opposes the caste perspective on social insects, whose locus classicus is Oster and Wilson's *Caste and Ecology in the Social Insects* (1978), reviews of her book have focused on the nature of this controversy while neglecting other equally important aspects of her work (e.g., Heinze 1999, Seeley 2000). By analyzing a variety of philosophical issues in her book, this review attempts to fill this lacuna.

One consideration in philosophy of science is whether *relations among* units or *properties of* units are more important in both scientific theories and nature. Gordon proposes that behavioral relations among ants, rather than physical properties of ants, explain the variance in ant and colony behavior both at a particular time and over time (Gordon 1991). *P. barbatus* workers do not have distinct morphological or physiological properties that determine their task. Depending on behavioral relations among ants, workers switch among tasks such as foraging, patrolling, nest maintenance, and midden work. Although the queen is morphologically, physiologically, and behaviorally distinct, her properties do not determine behavioral variance either. Gordon shows that a *P. barbatus* colony is organized in a non-hierarchical fashion.

With regard to the issue of task allocation, Oster and Wilson (1978) base their models of ant and colony behavior on species in which different worker castes *do* exist (e.g., four castes in the leaf-cutter ant *Atta laevigata* (198)). Castes are worker classes with distinct physical characteristics. Ants of different castes specialize in different tasks. In contrast to Gordon, Oster and Wilson explain behavioral variance primarily in terms of physical properties of ants rather than in terms of behavioral relations among ants. (119–124)

To some extent the differences among these biologists are due to a focus on different ant species. However, their work may also reflect philosophical differences concerning the relative importance of relations versus properties in determining behavior, fixity and change of individuals, and similarity and variation among individuals.

For example, Gordon hypothesizes that interaction *rate*, rather than interaction per se, can be an important explanatory factor. Her experiments and models indicate that an ant changes behavior as a consequence of the number of different ants it has antennal contact with per unit time, rather than any message transmitted by the contact itself. Furthermore, information concerning ecological conditions surrounding the system can be transmitted through interaction rates. These interesting proposals require further empirical and theoretical investigation.

A commitment dominating the literature on ants is that of intra-colony conflict and competition. In contrast to this view, the colony can be thought of as a "superorganism"—an integrated and cooperating higher-level individual—which develops as a unit without sub-unit competition. Populations of these units evolve in the context of their ecological setting. Gordon's intellectual ancestor, the myrmecologist William M. Wheeler (1911), argues that any "organism," whether a solitary aardvark or a teeming ant colony, exhibits three fundamental activities: nutrition, reproduction, and protection. There is division of labor among these processes so that, for example, some ants are reproductive while others are non-reproductive. Furthermore, sub-units interact cohesively through such mechanisms as chemical pheromones and interaction rates. Evolution occurs in populations of integrated superorganisms. Gordon adopts this useful perspective, further developed by others since Wheeler, in describing the life cycles of, and relations among, *P. barbatus* colonies. In light of the superorganism perspective, the "levels of *selection*" debate could be reanalyzed as a "levels of *cooperation*" or a "levels of *individuality*" debate.

Gordon balances the dual philosophical commitments of methodological reductionism and holism through three practices. She observes behavior at both the ant (part) and colony (whole) level. She examines behavior both by varying one factor at a time (e.g., perturbation experiments) and by having all factors vary in an undetermined fashion (e.g., observation without perturbation). She employs both holistic field studies and reductionistic laboratory investigations.

Whereas some philosophers of science have addressed the limitations of experimental randomization and *ceteris paribus* arguments, Gordon's discussion of this issue points to an interesting difference in commitments among practicing biologists. Some biologists hold that large sample sizes will randomize biases in, and correlations among, the fluctuations of different background experimental conditions and therefore context can be ignored, thereby saving valuable time. Other biologists, including Gordon (1999, 101) and Wade (1992), believe that background experimental conditions are patterned in predictable ways and context must be assessed in order to design more accurate experiments.

In summary, Gordon's insightful book depicts a broad experimental and theoretical research program. Any philosopher of science interested in a cogent biological research program, rich in material for philosophical analysis, should read *Ants at Work*.

(The reviewer is grateful to Sandhya Kilaru and Narisara Murray for commenting on earlier drafts of this review.)

RASMUS G. WINTHER, INDIANA UNIVERSITY

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*The Evolution Wars: A Guide to the Debate*s is a historical introduction to several controversies surrounding theories of biological evolution (primarily Darwinian) from the eighteenth and nineteenth centuries to the